



Original Research

Analysis Methods, Key Factors, and Strategies for an Integrated and Renewal Reading of UNESCO Heritage: The Cases of Pantelleria, the Aeolian Islands, and Mount Etna

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Abstract: Recognizing heritage sites such as UNESCO sites defines a complex framework in which conservation and enhancement processes are closely linked to their intrinsic capacity for renewal and their re-contextualization within the contemporary landscape. This necessitates a comprehensive reconsideration of actions and strategies within design disciplines, aiming for a systemic approach to interpreting territories, fostering territorial development and cultural innovation, while simultaneously preserving the integrity of natural and cultural assets. This article proposes a site analysis methodology that, through the identification of key factors, derived from the study *Il Patrimonio Immateriale UNESCO. Studio di progetto per un Osservatorio* [UNESCO Intangible Heritage. A Project Study for an Observatory], enables the delineation of the distinctive features of the sites—material, cultural, productive, and social—on which targeted operational scenarios can be developed. Based on a study of UNESCO sites in Sicily, conducted at the University of Palermo, the article examines three cases: two territorial systems (the Aeolian Islands and Mount Etna) and one intangible practice (traditional agricultural practice of cultivating the *vite ad alberello* [head-trained bush vines] of Pantelleria). The objective here is to apply and test the proposed methodology in diverse contexts to assess its effectiveness and replicability as a tool for site analysis and monitoring, as well as a preliminary framework for defining action scenarios in which design disciplines play a key role.

Keywords: UNESCO Heritage, Design-Driven Processes, Key Factors, Analysis Methods, Integrated Strategies

Introduction

The reflection developed in this article begins with the definition of cultural heritage (United Nations Educational, Scientific and Cultural Organization [UNESCO] 2003) as the set of physical elements, intangible forms and expressions, accumulated knowledge, and social practices that shape the identity of territories and communities through material artifacts, productive processes, industrial districts, and the individuals who embody that knowledge (Parente et al. 2017).

What emerges is the need for a holistic approach to the observation and understanding of sites as complex systems characterized by multiple factors—material and immaterial elements—and by interactions, dependencies, and relationships, which may constitute growth opportunities. This approach necessitates new modes of knowledge and interpretation (Zurlo 2003). These elements open renewed critical and design scenarios aimed at reconciling conservation concerns—focused on historical value—with transformative perspectives, interested in renewal and re-signification, ensuring their integration into contemporary contexts.

Design for the Sustainable Development of UNESCO Sites

UNESCO sites represent some of the most extraordinary examples of the world’s cultural and natural heritage. Selected for their transmission to future generations, these heritage sites have increasingly become opportunities for sustainable development in the territories and communities to which they belong, serving as carriers of strong identity value (UNESCO 1972).¹ Several key actions are established for their preservation: Conservation and Management, with Member States committing to protecting and preserving the sites by implementing effective management plans to ensure that the conditions justifying their Outstanding Universal Value are maintained and, where necessary, enhanced; Continuous Monitoring, ensuring the preservation of the sites’ integrity; Education and Awareness, aimed at fostering knowledge and understanding of the site’s value among local communities (Dari 2024).

Italy’s vast cultural heritage² has increasingly become the focus of renewed attention from various perspectives, providing an opportunity to reconsider issues of accessibility and sustainability in processes of heritage enhancement, renewal, and public engagement. In particular, the Faro Convention of 2005³ (Council of Europe 2005), adopted by Italy in 2020, emphasizes the significance of cultural heritage concerning human rights and democracy. It promotes a broader understanding of cultural heritage and its relationship with communities and society, highlighting the importance of the meanings and uses attributed to heritage by people, as well as the values it represents.

¹The *Convention Concerning the Protection of the World Cultural and Natural Heritage*, adopted by UNESCO in 1972, establishes that nominated sites may be inscribed on the *World Heritage List* (WHL) as cultural heritage, natural heritage, or, since 1992, cultural landscapes. That year, the Memory of the World Register was also introduced, listing documentary collections of universal significance.

² According to the latest update from the forty-sixth World Heritage Committee meeting in July 2024, the WHL comprises a total of 1,223 sites, including 952 cultural properties, 231 natural sites, and 40 mixed sites, across 168 countries. As of 2024, Italy holds the highest number of UNESCO sites globally (sixty sites), followed by China (fifty-nine), Germany (fifty-four), and France (fifty-three).

³The Convention was adopted by the Committee of Ministers of the Council of Europe on October 13, 2005 and opened for signature in Faro, Portugal, on October 27, 2005.

Every tangible manifestation of culture...is rooted in the knowledge required for its construction, the practices associated with its use, and the narratives arising from its very presence. The analysis of the relationship between tangible and intangible aspects thus extends to the idea of comprehensive resources, which design, as an act of cultural production, can observe, interpreting, designing, and communicating in terms of identity. (Parente et al. 2017, 3)

In this context, design and project disciplines at various scales of application (urban and territorial design, design for cultural production, co-design, product design, and design for social innovation) can support and facilitate the co-programming and co-design of sustainable processes for the conservation, protection, enhancement, and development of cultural heritage. Due to its relational nature and its ability to connect and integrate visions, methods, and values, design provides the tools to develop connective processes. It is becoming increasingly heterogeneous, interdisciplinary, and multi-stakeholder (Dellavalle 2023), involving businesses, public administrations, associations, universities, and research institutions.

Many UNESCO initiatives have focused on building education and awareness processes, working within schools and educational institutions. These initiatives have implemented best practices to disseminate and share knowledge and to affirm the value of heritage sites, also by establishing connections between different systems based on commonalities and distinctive characteristics.

The iHeritage project, co-financed by the ENI CBC Mediterranean Sea Basin Program of the European Union, involves six Mediterranean countries—Italy (Sicily), Egypt (Giza Pyramids), Spain (Alhambra), Portugal, Lebanon (Byblos), and Jordan (Petra). It aims to develop new solutions for promoting cross-border technology transfer through the establishment of Living Labs, the promotion of collaborative processes between industry and academia, the creation of spin-offs and new products, and the development of the Register of Intangible Heritage of the Mediterranean Countries (REIM). This register seeks to document and connect the “entire set of practices, representations, expressions, knowledge, and skills—including tools, objects, artifacts, and associated places—that communities, groups, and, in some cases, individuals recognize as part of their cultural heritage” across the Mediterranean countries participating in the project.

The Smart Education UNESCO Sicilia project, promoted by the *Dipartimento Regionale dell'Assessorato dei Beni Culturali e dell'Identità Siciliana* [Regional Department of Cultural Heritage and Sicilian Identity] and managed by the Archaeological Park of the Valley of the Temples in Agrigento, in partnership with various academic institutions and training organizations, aims to enhance the cultural heritage of Sicily's UNESCO sites. The project has engaged primary and secondary school students, as well as broader audiences, in the development of on-site sensory pathways to ensure full accessibility for all visitors. Simultaneously, it has designed an interactive, participatory online platform. Funded by the

Italian Ministry of Culture (MiC) through Law 77/2006 and co-financed by the Sicilian Region, this initiative seeks to establish, for the first time in Sicily, a synergy among the seven World Heritage-listed sites, by creating educational resources aimed at knowledge transfer regarding Sicily's cultural heritage. It also fosters connections between tangible and intangible heritage assets.

The analysis of Sicilian UNESCO sites, conducted with students of the *Laboratorio di Design per il Territorio*⁴ [Design Workshop for the Territory] (AY 2023–2024), led by Full Professor Viviana Trapani as part of the Master's Degree in *Design e Cultura del Territorio* [Design and Territorial Culture], DARCH—University of Palermo, has highlighted the diverse material and immaterial components of these eleven sites (Figure 1). The study identified an interconnected network of key terms (Figure 2), aimed at defining significant aspects and establishing a framework for reflection and the formulation of potential design scenarios. These scenarios seek to inform future interventions and the creation of narrative-driven material outputs.



Figure 1: Map of UNESCO Sites in Sicily
Source: Elaboration by Ambra Di Bernardi 2024

⁴ Today Design, Sostenibilità e Cultura Digitale del Territorio [Master's Degree in Design, Sustainability, and Digital Culture of the Territory].



Figure 2: Map of Keywords of Sicilian UNESCO Sites

Source: Elaboration by Ambra Di Bernardi 2024

From this broad and diverse overview, the study then focused on developing standardized tools for observing and interpreting heritage, ensuring their replicability to define categories for a preliminary investigation supporting design action.

The three heritage sites selected in this article—the practice of the vine-trained bush system, the natural system of the Aeolian Islands, and the vast landscape of Mount Etna—are examined using the model outlined in *Il Patrimonio Immateriale UNESCO. Studio di progetto per un Osservatorio* (Ministero della Cultura—Fondazione Scuola dei beni e delle attività culturali 2022),⁵ which identifies key fields for the observation and monitoring of intangible heritage. These fields include: (1) Practice, (2) Knowledge, (3) Transmission, (4) Environmental Conditions, and (5) Socio-cultural context. These categories have enabled a comparative analysis while simultaneously highlighting specific actions in the territories (key factors), identifying strengths and areas for potential improvement.

The examination of these three cases has allowed for the verification of the method's potential replicability in the study of tangible heritage as well. It has demonstrated the ability to outline and systematically organize the distinctive characteristics of each site, identifying value systems and territorial vocations. This approach provides a foundation for targeted future actions, tailored to the specific findings, and aimed at environmental conservation, sustainable territorial development, and social sustainability.

⁵ The project is conceived by the Ministry of Culture (MiC)—General Secretariat, Service II UNESCO Office—Fondazione Scuola dei beni e delle attività culturali.

The “Vite ad Alberello” of Pantelleria. Tradition, Landscape, and Community

The Intangible Cultural Heritage of the traditional agricultural practice of cultivating the *vite ad alberello* [head-trained bush vines] of the community of Pantelleria⁶ (Figure 3) is described highlighting the importance of the UNESCO recognition obtained in 2014 and the impacts it has generated on the territory from a socio-cultural and economic perspective. It explores the value of its promotion, demonstrating how these actions preserve local identity and ensure the continuity of the island’s winemaking tradition, contributing to its dissemination over time, maintaining its relevance, and keeping the agricultural landscape.



Figure 3: Vite ad Alberello of Pantelleria
 Source: Roberto Collura 2019

This centuries-old agricultural technique is deeply rooted in Pantelleria’s culture and resulted from centuries of adaptation by the island’s vine-growing communities to difficult climatic and geographic conditions. They have faced challenges posed by volcanic soil, strong winds, and limited water availability, developing know-how and cultivation methods that represent an example of agricultural sustainability and land conservation, embodying a profound integration between humans and nature. Known as “heroic viticulture,” this method has sustained the island’s economy and continues to be a symbol of human ingenuity in overcoming environmental challenges. The UNESCO recognition has had a significant

⁶ For the first time, an agricultural practice has been added to the Intangible Cultural Heritage of Humanity list.

impact, enhancing this agricultural technique, and reinforcing its role in preserving the island's cultural and agricultural diversity.

Table 1 provides the details on the head-trained bush vines of Pantelleria, extracted from the study *Il Patrimonio Immateriale UNESCO. Studio di progetto per un Osservatorio*.

Table 1: Grid for the Detection of the Vitality of Elements

<i>Field</i>	<i>Key Factors</i>
Practice	<ul style="list-style-type: none"> ▪ Community of practitioners: families and apprentices dedicated to traditional vine cultivation. ▪ Businesses engaged in traditional vine cultivation and wine production. ▪ Continuity of traditional vineyard/terrace cultivation practices.
Knowledge	<ul style="list-style-type: none"> ▪ Skills in soil preparation, vine planting, cultivation, and “bush-trained” maintenance according to traditional knowledge. ▪ Knowledge of land and landscape (vineyards, terraces, dry-stone walls, <i>dammusi</i>, Arab gardens). ▪ Skills in grape harvesting and wine production.
Transmission	<ul style="list-style-type: none"> ▪ Transmission of knowledge through formal (training courses) and informal (oral tradition, imitation) methods. ▪ Research collaborations and scientific publications. ▪ Preservation of historical elements in archives, museums, and multimedia platforms.
Environmental conditions	<ul style="list-style-type: none"> ▪ Suitable soils (lithosols, regosols, andic brown soils) and climate (constant winds, 11–25°C temperatures, dry summers). ▪ Limited wild animals and absence of vine pathogens.
Socio-cultural context	<ul style="list-style-type: none"> ▪ Allocation of public and private funds to support and promote the bush-trained vine and to encourage and facilitate young people. ▪ Initiatives for the conservation, recovery, and enhancement of material artifacts related to bush-trained vine cultivation. ▪ Formation of formal and informal groups of farmers, vine growers, winemakers, professionals, scientists, and citizens to promote vine cultivation. ▪ Limited presence of behaviors and socio-economic dynamics that could distort or compromise the culture and values of the practice. ▪ Presence of initiatives for the promotion and commercialization of the island's grapes and vines. ▪ Economic profitability of wine production (flow of goods and services and/or monetary flows).

The first element analyzed is *Practice*, which highlights the conditions necessary for the practice to continue. In Pantelleria, this is manifested through farming communities dedicated to vine cultivation using traditional methods. These practices are tied to the island's agrarian landscape, characterized by terraces and traditional structures such as dammusi⁷ and dry-stone walls⁸ (Figure 4).



Figure 4: The Dry-Stone Walls and the Vite ad Alberello
Source: Roberto Collura 2019

The second is Knowledge: this concerns the knowledge and expertise related to the cultivation of the vite ad alberello, including specific expertise in soil preparation, planting, vine care, and techniques of harvesting and wine production.

The third, Transmission of Knowledge, involves methods of preservation and transfer across generations. In Pantelleria, this occurs through formal and informal methods, including training courses and learning through imitation. Collaborations with academic and cultural institutions help ensure the production of scientific materials and preserve the historical memory of this agricultural practice. Archives, museums, and multimedia

⁷The *dammuso* is the unique and unrepeatable result of a slow, timeless process of co-evolution and adaptation to its environment—shaped by the landscape, climate, colonizers, prevailing winds, and available materials.

⁸The dry-stone wall is a distinctive construction technique where stones are carefully arranged and assembled without the use of binders or mortar. In 2018, it was inscribed on the UNESCO WHL.

platforms, such as the Virtual Museum of Alberello Vine, play a fundamental role in preserving this knowledge and its cultural significance.

The fourth, Environmental Conditions, are crucial for the success of vite ad alberello cultivation. They should be monitored, as the absence of significant precipitation during the summer, the limited presence of wild animals, and the lack of harmful pathogens are essential for vine growth.

The fifth field of observation concerns the Socio-cultural Context, which focuses on elements without which the practice risks extinction. These include the allocation of public and private funds, initiatives for preserving material artifacts, and socio-economic dynamics influencing vine cultivation. Local groups dedicated to promoting viticulture and supporting wine commercialization are also monitored, along with the economic profitability of the agricultural activity. In Pantelleria, these elements are applied through the allocation of funds to protect and enhance the vite ad alberello, encouraging younger generations to continue this tradition. For instance, the *Parco Nazionale dell'Isola di Pantelleria* [Pantelleria Island National Park], in collaboration with the Municipality of Pantelleria and The Ministry of Culture, has organized workshops and training sessions focused on grafting and pruning techniques. The Pantelleria DOC Wine Consortium, leveraging European funds, works to promote local wines and engage farmers, fostering economic growth through wine tourism. This is linked to pathways dedicated to vite ad alberello, an important attraction for visitors interested in the island's cultural and natural heritage. The emphasis on monitoring the economic profitability of wine production ensures that viticulture continues to contribute to the island's sustainable development.

The Pantelleria Island National Park, established in 2016, has promoted and preserved the traditional vite ad alberello cultivation, culminating in the creation of the Virtual Museum of Alberello Vine in 2023. This museum serves as an archive of testimonies from farmers and producers who have kept this agricultural practice alive, emphasizing its connection to the island's landscape management and the cohesion of the local community. The museum's website allows users to explore expert narratives and practitioners' insights, as well as access a detailed map of the territory, including an itinerary for the vite ad alberello with information on the island's vineyards, promoting Pantelleria's viticultural heritage. The museum represents a thoughtful design response to conservation challenges, recognizing the vite ad alberello as a cultural symbol reflecting the hard work and dedication of those who nurture its growth.

As part of the *Laboratorio di Design per il Territorio*, some students (Cristina Accardi, Costanza Giambruno, and Soraya Pizzimenti) focused their studies on this agricultural practice. Their research analyzed the unique characteristics of the practice and the island's agricultural production context, aiming to highlight the deep connection between the local terroir and wine production. The project illuminated the role of design in enhancing heritage value, showing how design can facilitate a deeper understanding of the relationships between history, culture, traditional techniques, heritage, biodiversity, and landscape. The creation of

an interactive map and website served as an example of how design can be a catalyst for the conservation, safeguarding, and promotion of intangible heritage.

Design emerges as an active engagement tool, helping to build a dialogue between the past and present, stimulating dynamic and informed narratives that foster greater community awareness, expand knowledge of the practice beyond the local context, and contribute to the appreciation and development of this agricultural technique.

The analysis of this case study has highlighted how the success of the vine-training system *vite ad alberello* in Pantelleria lies in its ability to integrate economic, social, and environmental sustainability, and how the promotion of DOC wines and enogastronomic tourism ensures economic profitability. UNESCO recognition, on the other hand, has contributed to strengthening cultural identity and encouraging the transmission of intergenerational knowledge. This resilient agricultural practice preserves traditional landscapes and biodiversity, representing a virtuous model for the protection of cultural heritage and sustainable development.

Aeolian Islands: Biodiversity, Sustainable Development, and Heritage

The Natural World Heritage Site of the Aeolian Islands⁹ (Figure 5), recognized by UNESCO in 2000, highlights the significance of preserving the islands' cultural and environmental integrity and fostering community cohesion. This analysis explores how effective land management strategies contribute to sustainable development while integrating environmental protection with the enhancement of local traditions and resources, emphasizing community activation and participatory tools.

The Aeolian Islands, a volcanic archipelago in the Tyrrhenian Sea north of Sicily, comprise seven main islands—Lipari, Vulcano, Salina, Stromboli, Filicudi, Alicudi, and Panarea. They hold exceptional scientific, landscape, and cultural value. UNESCO recognition marked a turning point, increasing attention on biodiversity conservation and the islands' unique characteristics. Previously, resources and coordination among stakeholders were limited. Recognition catalyzed initiatives by associations, foundations, and institutions aimed at promoting sustainable resource management and historical preservation. However, in recent years, the rise in tourism has raised concerns about ecosystem pressures, necessitating a balance between economic growth and environmental sustainability.

⁹ The Aeolian Islands were inscribed on the UNESCO WHL under criterion VIII for their morphology, which serves as a historical model in the evolution of global volcanological studies. They are an outstanding example of ongoing volcanic activity.



Figure 5: The Aeolian Islands
Source: Paolo Segneri 2024

Design plays a critical role in this balance, offering sustainable guidelines and fostering the integrated management of cultural and environmental resources. Through a multidisciplinary approach, the design encourages tools and practices for active community engagement, facilitating dialogue among residents, institutions, and visitors.

Testing the methodology outlined in Table 1, this research has defined the key factors that identify the elements of the vitality of the Aeolian Islands (Table 2).

Table 2: Grid for the Detection of the Vitality of Elements

<i>Field</i>	<i>Key Factors</i>
Practice	<ul style="list-style-type: none"> ▪ Management of a natural site of great scientific and landscape significance, renowned for volcanic activity and unique biodiversity. ▪ Conservation of volcanic landscapes and biodiversity, with monitoring and study of volcanic activities. ▪ Aeolian craftsmanship includes lava stonework, ceramics, and traditional musical instruments.
Knowledge	<ul style="list-style-type: none"> ▪ Expertise in volcanology, geology, and marine biology, with knowledge of the archipelago's ecological and volcanic dynamics. ▪ Schools and local authorities promote educational programs to raise awareness among younger generations about conserving natural and cultural heritage.

Transmission	<ul style="list-style-type: none"> ▪ Educational and awareness activities on the importance of the site (e.g., guided tours, conferences). ▪ Local associations preserve cultural and natural heritage, collaborating with universities and international institutions. ▪ Presence of places that ensure the preservation of the historical significance of the element (e.g., archives, museums, documentation centers, multimedia platforms).
Environmental conditions	<ul style="list-style-type: none"> ▪ The archipelago consists of seven volcanic islands with a Mediterranean climate. ▪ Ecosystems are rich in endemic species, while volcanic soil supports vines and olive trees. ▪ Winds like sirocco and mistral shape landscapes and influence navigation.
Socio-cultural context	<ul style="list-style-type: none"> ▪ Support for the local population in managing natural resources. ▪ Promotion of sustainable tourism to preserve the natural heritage. ▪ The inhabitants have traditionally lived off fishing and agriculture, which still play an important role today, although tourism has taken on increasing significance. ▪ The islands keep alive numerous religious and folkloric festivals, which represent a moment of strong community identity. ▪ The local population is involved in initiatives to conserve the fragile ecosystem of the islands, with particular attention to protecting marine resources and volcanic areas.

Practice: even in the Aeolian Islands, land management is strongly based on landscape conservation, with attention directed toward safeguarding local biodiversity and the ecological dynamics that regulate its balance. Alongside this, rooted artisanal traditions, such as the working of lava stone and the production of traditional musical instruments, intertwine natural heritage with local culture, reinforcing the connection between the environment and territorial identity.

Knowledge (scientific and cultural expertise): extensive expertise in volcanology, geology, and marine biology characterizes the Aeolian Islands. This body of knowledge is further enriched by collaborations between local educational institutions and organizations, such as the Centro Studi e Ricerche Eoliano [Aeolian Study and Research Center], which have promoted educational programs over the years to raise awareness among younger generations about the importance of conserving both the natural and cultural heritage of the archipelago.

Transmission of Knowledge on the islands occurs through various educational activities, including guided tours and lectures, frequently supported by local associations committed to preserving the archipelago’s history and ecosystem. Among these, Filicudi Wildlife

Conservation, an organization dedicated to the preservation of local fauna and flora, and the Aeolian Study and Research Centre, active for over forty years in research and the promotion of Aeolian culture and history, stand out for their significant contributions. Another example is the DottEolie Association, which is currently inactive and had previously focused on creating socio-cultural initiatives aimed at protecting and promoting the area.

These efforts have also materialized in the creation of archives, museums, and documentation centers aimed at preserving the historical memory of the archipelago. A notable example is the Memory Ecomuseum in Lipari, which aims to preserve and promote local traditions and the cultural identity of the islands. Similarly, the Luigi Bernabò Brea Archaeological Park and Museum provides important testimony to the ancient history of the Aeolian Islands through its collection of archaeological artifacts. Other documentation centers, though some are no longer active, have nevertheless contributed to a rich landscape of cultural and historical resources, enhancing the understanding of the islands' cultural heritage. These organizations play a crucial role in safeguarding the islands' socio-cultural and economic integrity, acting as guarantors of long-term sustainability. Therefore, their activities should be promoted and supported, as they are central to preserving the identity of the communities and the environment. Continuous monitoring by public institutions and/or private entities can ensure the effective pursuit of conservation and development objectives, allowing emerging critical issues to be identified and timely interventions to be made to protect the heritage and keep the islands' legacy and identity alive.

A fourth element is represented by Environmental Conditions. The islands of the archipelago are characterized by a Mediterranean climate, with constant winds shaping the landscape and affecting navigation routes, and volcanic soil, particularly fertile and suitable for cultivating vines, such as Malvasia of Lipari, and a wide variety of olive trees. Environment preservation, which significantly contributed to UNESCO recognition, is essential not only for protecting natural heritage but also for maintaining this precious balance. A virtuous example, born from the desire to protect and restore the ecosystems of Sicily and its minor islands for the benefit of all and with the active involvement of local communities and conservation groups, is the Sicily Environment Fund (SEF). The foundation, created by the Aeolian Island Preservation Fund (AIPF), is a member of the Conservation Collective, a global network of locally focused environmental foundations dedicated to the conservation, protection, and regeneration of biodiversity-rich ecosystems. *SEF* works by raising funds from individuals and businesses to support the most effective organizations and projects, aiming for replicability and building strong collaborative networks. It also promotes education, knowledge sharing, and collaboration with local communities, ensuring that sustainable practices, such as responsible tourism and resource management, can be scaled and effectively applied in other areas.

From a socio-cultural perspective, the local population plays an active role in natural resource management and the promotion of sustainable tourism, oriented toward the

conservation of natural heritage. Historically, communities have based their livelihoods on fishing and agriculture, activities that, although less central, remain relevant. Other noteworthy elements include religious and traditional customs, such as those promoted by the Eolian Musical Association San Bartolomeo, which reinforce the sense of community and belonging. As previously described, the population actively participates in ecosystem conservation initiatives, focusing on the protection of marine resources and volcanic areas.

The design project led by students (Federica Lamberti and Salvatore Massaro) in the *Laboratorio di Design per il Territorio* represents an innovative approach to enhancing this heritage. The creation of an interactive map aims to simplify and disseminate information, making it accessible to residents, students, researchers, and tourists. It serves as both an educational and informational tool, with design playing a fundamental role as a driver of social and cultural change. By facilitating access to valuable knowledge, it contributes to the development of a strong sense of belonging and responsibility toward the heritage. It also marks an important step in the promotion of conservation policies that encourage responsible and sustainable tourism, capable of respecting the identity of local communities and their productions, while fostering collective commitment to the protection of the Aeolian Islands.

The interest in this case study lies in the profound integration between cultural enhancement, environmental conservation, and sustainable development, focusing on effective land management strategies, community engagement, and the preservation of biodiversity and local traditions. Initiatives such as interactive tools and educational programs have facilitated knowledge sharing and increased awareness among people, while the synergy between scientific research, innovative design, and land management policies has demonstrated that environmental and cultural protection can coexist with sustainable and responsible tourism, contributing to the well-being of local communities. These efforts have ensured that the islands remain a model of synergy between nature, culture, and science. However, the challenge remains to balance economic growth and sustainability to prevent the emergence of negative phenomena such as over-tourism, intensive resource exploitation, and land speculation.

Mount Etna: Landscape, Material Productions, and Productive Systems

The heritage of “Mount Etna” (Figure 6) is described here based on its unique natural and geological features, whose cultural and scientific significance was highlighted by the UNESCO recognition obtained in 2013, defining the volcanic landscape as an “extraordinary example of ongoing geological processes and volcanic formations.”¹⁰

¹⁰ Mount Etna was inscribed on the WHL under Criterion VIII as an outstanding example of major stages in Earth’s history, showcasing records of life, ongoing geological processes, and significant landforms.



Figure 6: Mount Etna
Source: *Formafantasma*

The distinctive elements that comprise the volcano—such as the summit craters, ash cones, lava flows, lava caves, and the Valle del Bove depression—have made Mount Etna a prime destination for scientific research and education. The Mount Etna site serves as a significant hub for volcanology, geophysics, and other earth sciences disciplines.

Following the methodological approach outlined in Table 1, the key factors for the Mount Etna site can be summarized as follows (Table 3).

Table 3: Monte Etna: Grid for the Detection of the Vitality of Elements

<i>Field</i>	<i>Key Factors</i>
Practice	<ul style="list-style-type: none"> ▪ Management and monitoring of an active volcano are essential for safety and scientific research. ▪ Agricultural practices in volcanic areas, focus on typical products such as wine, honey, and pistachios. ▪ Extraction of lava stone/use in historic architecture as a cladding material. ▪ Sustainable hiking and tourism in protected areas.

Knowledge	<ul style="list-style-type: none"> ▪ Expertise in volcanology, geology, and natural resource management. ▪ Agricultural traditions related to vineyard cultivation on volcanic soil. ▪ Knowledge of biodiversity and local ecosystems. ▪ Extractive techniques and specialized processes in lava stone processing.
Transmission	<ul style="list-style-type: none"> ▪ Educational and outreach activities in schools and local institutions to raise awareness of natural heritage conservation. ▪ Collaborations between universities, research centers, and local associations/companies for the study of the volcano and its characteristics. ▪ Existence of historical documentation and research centers. ▪ Establishment of the Museo della Vulcanologia dell'Etna [Etna Volcanology Museum]. ▪ Creation of the Parco dell'Etna [Etna Park]. ▪ Formation of the Lava Stone Production District. ▪ Recognition of Etna DOC, the first controlled designation of origin in Sicily.
Environmental conditions	<ul style="list-style-type: none"> ▪ The presence of highly fertile volcanic soils, ideal for specialized crops. ▪ Unique ecosystems featuring endemic animal and plant species. ▪ Mediterranean climate with temperature variations linked to altitude and constant winds. ▪ Ongoing soil and volcanic rock regeneration/geological stratification with unique characteristics.
Socio-cultural context	<ul style="list-style-type: none"> ▪ Traditions and legends linked to the volcano are deeply embedded in local culture. ▪ Local communities actively engaged in natural resource management and the promotion of sustainable tourism. ▪ Religious and cultural festivities that reinforce the identity of the region.

Practice and Knowledge

The ancient art of vine cultivation is deeply rooted in the composite nature and fertility of Etna's soil. In 1881, marking the pivotal role of local viticulture, the Royal Decree established the *Scuola Enologica* [School of Oenology], followed in 1886 by the creation of the *Ufficio Enologico* [Oenological Office] to oversee and regulate Etna's wines. On August 11, 1968, Etna DOC was officially recognized as the first controlled designation of origin (*Denominazione di Origine Controllata*, DOC) in Sicily. In 1999, Salvo Foti founded the consortium *I Vigneri. La Maestranza dei Vigneri*, a forward-thinking initiative recognizing the essential role of viticulturists as vineyard professionals and the need to pass down traditional knowledge, techniques, and expertise to future generations. Key aspects include the exclusive use of the

alberello vine-training system, the valorization of native grape varieties, respect for the environment, and the invaluable craftsmanship of *La Maestranza dei Vigneri*, a group of highly skilled Sicilian vineyard workers.

Viticulture extends across the northern, eastern, and southern slopes of the volcano, covering the territories of twenty municipalities in the province of Catania. The grape varieties, shaped by diverse environmental conditions—ranging from altitude and volcanic soil composition to exposure to winds and temperature variations—produce wines of distinct character, including *Nerello Cappuccio*, *Carricante*, and *Nerello Mascalese*.

Lava flows shape the Etnean landscape (Trapani 2018), and volcanic stone has long served as a primary material in historic architecture. More recently, experimental design projects have sought to reinterpret its narrative potential. In the *De Natura Fossilium* project (2014), the *Formafantasma design studio* explored the properties of volcanic stone, reimagining the relationship between objects, materials, and local culture. This research involved collaborations with the *Centro Vulcanologico di Catania* [Catania Volcanological Centre] for studying volcanic processes, the *Audax Textile Museum* in Tilburg (Netherlands) for producing textile fibers from volcanic rock, and *Berengo Studio* in Murano alongside the *Glass Museum* in Leerdam (Netherlands) for the fusion and processing of volcanic glass. The project resulted in a collection of objects reflecting the narratives embedded in the Etnean landscape (Figure 7).

Transmission of Knowledge

To communicate the global scientific and natural significance of the volcano, the Provincial Authority of Catania inaugurated the *Museo Vulcanologico dell'Etna* [Etna Volcanological Museum] in 2003. The museum consists of two sections: the *Documentation Centre*, which features photographs and large-scale images depicting key evolutionary phases of major eruptions over the past two decades, alongside a scaled model of the Etnean territory; the Educational Section, which presents a collection of volcanic rock samples, including scoria, hematite crystals, sulfur crystals, silicates, and volcanic bombs.

The establishment of the *Distretto Produttivo della Pietra Lavica* [Productive District of Lava Stone]¹¹ finds its most distinctive and ineffable socio-cultural and productive identity in Mount Etna. It is worth noting that, in recent years, Sicily has seen a rise in small and medium-sized enterprises across various sectors, with advanced technological capabilities. Specifically, in the stone materials processing industry, patented circular processes have been developed to enhance the characteristics, quality, and intrinsic value of lava stone. The company *Nerosicilia* (Chiaromonte Gulfi, RG) has distinguished itself over time for developing industrial processes that transform the material's surface, improving and diversifying its properties exclusively through heat treatment in specialized furnaces.

¹¹ Sicilian Region—Regional Department of Cooperation, Commerce, Crafts, and Fisheries Decree n.152 of 1/12/2005 (GURS n.57 of December 30, 2005).



Figure 7: Formafantasma, De Natura Fossilium, Small Pillar
Source: Luisa Zanzani

The *Laboratorio di Design per il Territorio* project experiment focused on the reuse of production waste (medium to large fragments) of lava stone from Nerosicilia. Developed by students Daniele Caruso and Alberto Dolce, the project involved designing a metal framework to accommodate waste slabs, creating a modular system for variable and customizable compositions of tabletops, benches, and seating surfaces (Figure 8).



Figure 8: Daniele Caruso, Alberto Dolce. Detail of the Design of a Table Made from Lava Stone Processing Waste
Source: Roberto Collura 2024

The landscape shaped by Mount Etna has also served as a reference framework for reflecting on territorial challenges and exploring potential design-driven responses. Within the *STONE* (SusTainable ecOdesign reusiNg quarrying wastE¹²) project—MICS,¹³ which involved multiple Italian universities and established collaborations with local businesses, the research group at the University of Palermo (Lava Stone District—Prof. Viviana Trapani, RTDA Serena Del Puglia) initiated several experimental studies. These studies were further supported by the *Laboratorio di Edilizia di Palermo* [Building Laboratory of Palermo] (Prof. Simona Colajanni and Prof. Manfredi Saeli) in the development of innovative materials (students: Miriam Arigò, Luana Capizzi). By employing natural binders, these materials aim to incorporate and repurpose the substantial quantities of ash and lapilli generated by the volcano's eruptions, which currently require extensive collection operations and disposal in landfills.¹⁴ This approach fosters the integration of sustainable production processes with strategies for territorial enhancement and identity valorization, yielding original outcomes in material production, including process optimization, product innovation, the design of advanced materials, and technological transition through digital methodologies.

Environmental Conditions

Mount Etna supports significant terrestrial ecosystems, including endemic flora and fauna, while its ongoing volcanic activity renders it a natural laboratory for studying ecological and biological processes. The Etna Park, the first to be established among Sicily's protected areas (D.P.R. 17/03/1987), was created with the primary objective of safeguarding its unique environmental and landscape features while promoting the eco-compatible development of local communities.

Etna is also the largest composite basaltic volcano, covering an area of approximately 1,250 km² above sea level. The distinctive nature of its soil, along with its potentially infinite regenerative capacity, has given rise to one of the most defining productive activities in the Etnean landscape—the extraction and processing of lava stone. The basalt ejected by the volcano has long been shaped by the craftsmanship and artistic ingenuity of local artisans. The eighteenth-century reconstruction of Eastern Sicily following the devastating 1693 earthquake

¹² Project leader: Prof. Fabio Fatiguso. Politecnico di Bari. Spoke 2. Eco-Design strategies: products, services, and systems.

¹³ This study was carried out within the MICS (Made in Italy—Circular and Sustainable) Extended Partnership and received funding from the European Union Next-Generation EU (PIANO NAZIONALE DI RIPRESA E RESILIENZA [PNRR]—MISSIONE 4 COMPONENTE 2, INVESTIMENTO 1.3—D.D. 1551.11-10-2022, PE00000004). This manuscript reflects only the authors' views and opinions, neither the European Union nor the European Commission can be considered responsible for them.

¹⁴ Il Progetto Reucet. Recupero e utilizzo delle ceneri vulcaniche etnee [Reucet Project. Recovery and Use of Mount Etna Volcanic Ash]—Scientific Director: Prof. Paolo Roccaro, Environmental Sanitary Engineering, University of Catania—conducted a three-year (2018–2020) research study on the possibilities for recovering volcanic ash, identifying several applications in the construction, ceramics, and agriculture sectors.

represents the pinnacle of architectural use of Etnean basalt, epitomized by the masterpieces of Catanese Baroque, which continue to define the historic center of Catania today.

Socio-Cultural Context

The Etna region emerges as a system strongly characterized by its natural, landscape, and—partially—artistic and architectural values, alongside unique productive qualities. This fertile territory has successfully transformed its physical–environmental conditions, cultural heritage, and material production (at various scales) into attractive strengths, further reinforced by UNESCO recognition.

A comprehensive tourist flow analysis (Overall Tourist Flow Analysis), conducted by Etna Park in collaboration with the University of Catania (Dr. Alfredo Pasqualino), has highlighted the significant impact of UNESCO designation on the trends of visitors to Etna Park. When compared with tourism trends in the metropolitan area of Catania and the broader Sicilian region, the analysis draws particular attention to the two main access routes—Nicolosi and Linguaglossa—while also identifying critical gaps in hospitality and service infrastructure that require enhancement. The recognition of Mount Etna as a UNESCO site has not only boosted tourist flows but has also intensified efforts in heritage valorization, research, and the experimental development of its most authentic and distinctive productive aspects, further strengthening the site’s overall image and appeal.

The case of Mount Etna underscores a synergy of deeply interconnected elements, where analytical categories reveal a continuous interplay that resists rigid classification. This highlights the necessity of a holistic approach to heritage management, one that simultaneously ensures the preservation of invaluable environmental ecosystems and fosters sustainable development processes. Such an approach seeks to enhance local knowledge, traditional practices, and material productions, demonstrating how sensitive and respectful engagement with the territory can unlock its latent potential while safeguarding its unique identity.

Conclusions

The comparative analysis presented in this article highlights how cultural and environmental protection, sustainable development, and social sciences—combined with participatory tools and active community engagement—can enhance natural and cultural resources while simultaneously fostering sustainable territorial development. It emerges that UNESCO recognition extends beyond its mere symbolic value, triggering complex dynamics that influence the socio-cultural and economic evolution of the designated territory. The role of design within this process is to act as a catalyst for change, innovatively integrating diverse needs related to conservation, enhancement, and development while guiding territorial practices toward solutions that respect local history and traditions while simultaneously addressing contemporary challenges of sustainability and inclusion. Design thus assumes a

systemic approach that translates into concrete and practical actions, creating opportunities for community engagement, stimulating active participation, strengthening local identities, and fostering the emergence of new sustainable economic and social models.

The research presented here has, therefore, validated a replicable and scalable analytical method, enabling the definition of a series of design guidelines and tools applicable across different contexts and scales. The six main categories of intervention, developed to provide a framework for integrated and sustainable actions, are outlined chronologically in Table 4.

Table 4: Categories, Tools, and Outputs

	<i>Category</i>	<i>Tools</i>	<i>Outputs</i>	
1	Documentation and research	<ul style="list-style-type: none"> ▪ Mapping and cataloging ▪ Identification and sharing of best practices ▪ Multi-actor collaboration (institutions, universities and companies) 	Comprehensive heritage databases, deeper heritage understanding, dissemination of best practices, and strong academic partnerships	Interdisciplinary and integrated approach: Holistic heritage management strategies, integration of diverse expertise, alignment with local development goals, and environmentally sustainable practices
2	Active involvement of local communities	<ul style="list-style-type: none"> ▪ Participatory and inclusive processes ▪ Community empowerment ▪ Creation of local networks 	Increased community participation, empowered local stakeholders, inclusive decision-making processes, and strengthened local networks	
3	Use of innovative technologies	<ul style="list-style-type: none"> ▪ Digitalization ▪ Platforms for sharing ▪ Interactive applications 	Enhanced digital documentation, improved public accessibility, interactive visitor experiences, and efficient resource management	
4	Development of sustainable and responsible tourism	<ul style="list-style-type: none"> ▪ Management of tourist flows ▪ Involvement of local businesses ▪ Integrating the tourist into local processes 	Balanced tourism growth, empowered local businesses, managed visitor flows, and authentic cultural experiences	

5	Promotion of new narratives and interpretations	<ul style="list-style-type: none"> ▪ Cultural narration ▪ Communication of tangible and intangible aspects 	Engaging cultural narratives, connecting historical and contemporary identities, and enhancing heritage relevance	
6	Evaluation of social and economic impacts and replicability of the model	<ul style="list-style-type: none"> ▪ Performance indicators ▪ Community feedback 	Measured project impacts, responsive community feedback, economically viable projects, and continually improved strategies	

The first category concerns documentation and research, an initial and indispensable phase to ensure a thorough understanding of the area and to identify key stakeholders. This preliminary investigation process is crucial for building a solid knowledge base that provides essential insights for subsequent stages, allowing interventions to be tailored to the specificities of the territory, the real needs of the local community, and its socio-cultural dynamics (Ministero dell'Università e della Ricerca 2020).

Active involvement represents the second strategic step. The concept of “community” holds decisive value in shaping social and cultural imagination, making its interpretation essential for those engaged in public policies and regenerative interventions (Niessen 2023). These communities—forming the connective and identity fabric of a territory—today face numerous challenges related to phenomena such as over-tourism and cultural homogenization, with the tangible risk of seeing their local peculiarities disappear (Gainsforth 2023). In this scenario, while tourism remains a crucial economic resource, if poorly managed, it can contribute to the impoverishment of the socio-economic fabric. Conversely, participatory and shared projects that regard communities as central actors in heritage conservation and enhancement—as custodians of values, traditions, knowledge, and practices—enable active community involvement in defining territorial policies, making them key players in processes of cultural and economic regeneration (European Commission 2014; Teti 2022). Finally, establishing collaborative networks between institutions, managing bodies, and local communities facilitates the dissemination of effective models, promotes synergies, and addresses shared challenges through continuous and interdisciplinary dialogue (Villari 2013; Manzini 2015; Ferrara et al. 2022).

The development of sustainable and responsible tourism constitutes the third critical area, particularly in territories experiencing high tourist pressure. It is essential to implement strategies that mitigate the negative impacts of mass tourism and promote a balance between tourism promotion and the protection of territorial resources and local communities (Keough 2011; UNWTO 2018). Well-planned, diversified tourism that is environmentally

and culturally respectful can become a key resource for economic development without compromising residents' quality of life or ecosystem protection.

The adoption of innovative technologies represents the fourth area of intervention. Digital technologies and advanced visualization tools, such as interactive platforms or augmented reality applications, alongside design methodologies and expertise, offer new opportunities to enhance the accessibility of cultural information and enrich user experiences without compromising heritage preservation (Ferrara et al. 2022).

The promotion of new narratives and interpretations constitutes the fifth key aspect. Through design, it is possible to renew the perception of heritage, creating new modes of interaction and innovative narratives that, developed in synergy with residents, strengthen the bond between people and places, contributing to the preservation of traditions and the construction of contemporary territorial identity (Trapani and Del Puglia 2022).

Finally, the evaluation of social and economic impacts and the replicability of the model represent the final phase. Defining success indicators and implementing monitoring systems is essential to assess the impact of the adopted strategies in terms of social inclusion, environmental sustainability, and economic growth (Ministero 2020). Ongoing analysis of results allows for the identification of strengths and weaknesses, promoting the optimization of interventions and ensuring that enhancement initiatives remain sustainable in the long term (Fondazione Symbola—Unioncamere 2023). Furthermore, to facilitate the replication of best practices, it is beneficial to develop operational tools, such as manuals, toolkits, or digital platforms, which compile tested methodologies and case studies. These tools can support managers in planning sustainable interventions by providing concrete references for the implementation of effective strategies.

Further investigation into the long-term impacts of UNESCO recognition will enable an analysis of the additional enabling factors that facilitate effective and sustainable interventions capable of transforming recognition into a tangible opportunity for territorial enhancement and innovation. Additionally, the research will focus on the skills and expertise necessary for an integrated approach to heritage management—bringing together design, urban planning, social sciences, and communication.

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Informed Consent

The authors declare that informed consent was not required as there were no human participants involved.

Conflict of Interest

The authors declare that there is no conflict of interest.

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